MEMOIRS

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IV.

The Latitude of the Cambridge Observatory, in Massachusetts, determined, from Transits of Stars over the Prime Vertical observed during the Months of December, 1844, *and January,* 1845, *by*

WILLIAM C. BOND, A. A. S.,
DIRECTOR OF THE CAMBRIDGE OBSERVATORY,

MAJOR JAMES D. GRAHAM, A. A. S.,
OF THE UNITED STATES CORPS OF TOPOGRAPHICAL ENGINEERS,

AND

GEORGE P. BOND,
OF THE SENIOR CLASS IN HARVARD UNIVERSITY.

BY BENJAMIN PEIRCE, A. A. S.,
PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

THE latitude of Harvard Hall in Cambridge was determined by Professor Williams, in the years 1782 and 1783. His observations were made upon meridian altitudes of the sun, and of north and south stars, including the pole star, with a Sisson's quadrant

of two and a half feet radius. They are published in the first volume of the Transactions of this Society, and agree together quite creditably to the observer. They give for the latitude of the observatory 42° 23′ 52″ N.

Mr. Paine's 584 observations of the latitude of Boston, made, in 1828 and 1829, with two of Ramsden's sextants (the results of the two different instruments agreeing to the tenth of a second), and published in the first volume of the new series of the Transactions, give for the latitude of the Observatory* 42° 22′ 22″.3 N.

Mr. Paine's more recent observations of the latitude of Boston, made for the survey of the State and published in the Memoirs of the American Philosophical Society, give for the latitude of the Observatory* 42° 22′ 47″.2 N.

Mr. Paine's observations of the latitude of the Unitarian Church in Old Cambridge give for the latitude of the Observatory* 42° 22′ 46″.7 N.

The latitude resulting from the series of observations contained in this memoir is 42° 22′ 49″ N.

The agreement of the observations with each other, no one of which differs from the mean more than *three seconds*, shows that this latitude may be depended upon as accurate to about a second. Had simultaneous observations of the stars employed been made at Greenwich, or some other established observatory, the resulting latitude might have been depended upon to one half or one third of a second; and it is probable that, under favorable circumstances, this system of observation will give differences of lati-

* The differences of latitude necessary for these reductions were obtained from Mr. Charles O. Boutelle, who has made some careful trigonometrical observations of these differences of latitude, and has kindly communicated to the Observatory a copy of his results.

tude accurate to the tenth of a second, and thereby resolve some interesting inquiries in topography and geology.

Great changes of temperature occurred in the course of the observations, which materially affected the level, and thereby most seriously interfered with the efforts to attain accurate results. The observers were, moreover, wholly unused to this class of observations, neither of them having before observed upon the prime vertical.

Description of the Instruments.

Chronometer. — The time was kept, throughout the observations, by a chronometer belonging to Major Graham, and numbered 2419. This watch had been proved, by previous use, to be of uncommon excellence. Its rate, determined by means of the meridian transit instrument, was small, and is shown in Table I.

Transit Instrument. — The transit instrument, which was employed in the observations upon the prime vertical, was made by Troughton and Simms, of London, and was kindly lent to the Observatory, for this purpose, by Major Graham. It is of about four feet focal length, and three inches aperture, with very clear and distinct vision. It has seven vertical and three horizontal wires; the seven vertical wires are described in the observations as *A*, *B*, *C*, *D*, *E*, *F*, *G*; the order in which they are lettered commences with the wire nearest to the illuminated end of the axis. The intervals between the wires were not known from any independent astronomical observations; but this is unimportant, for a knowledge of them is not required in the methods of observation and reduction here employed. These intervals have, however, been approximately determined by terrestrial observations and the micrometer; and a comparison of them with their values deduced from

the transit observations, which is made in Table V., will serve to test the accuracy of the observations.

The transit instrument has two very delicate levels, adapted to different temperatures, and each divided to seconds.

The middle wire (D), was carefully adjusted by Mr. Bond previously to the observations; and he could not detect any error of collimation, either at that time or at the close of the series.

The telescope was mounted upon heavy stone piers, which rested securely upon a stone foundation.

Method of Observation.

Each star was observed at its east and west transit over each wire of the telescope. The axis of the telescope was reversed every few days, which is indicated in the tabular account of the observations by the column which gives the position of the illuminated axis as being north or south.

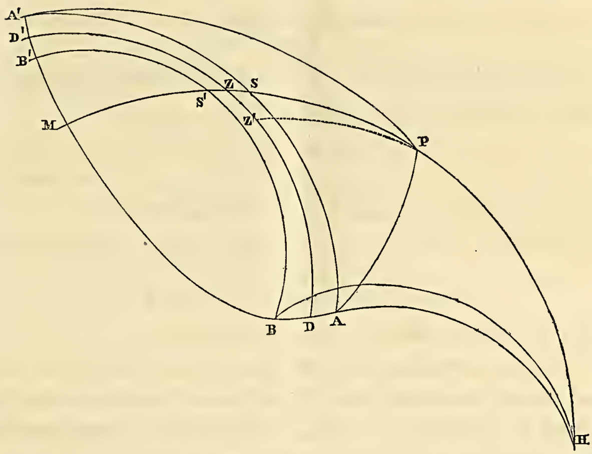
The level was usually read before and after each observation, and was commonly reversed three or five times. About five minutes were allowed, after each reversal, for the level to settle.

Since each observation of the level often corresponded to two different observations of a star, it is convenient to print all the observations of the level in the single Table III.

The observations of the transits of the stars are given in Table IV. The time is that of the chronometer, No. 2419.

Method of Computation.

Let $D Z D'$ be the arc of a great circle described by the axis of collimation of the telescope; $P Z M$ the meridian perpendicular to $D Z D'$; $D M D'$ the arc of a small circle described by the star. $\mathcal{A}$ and $\mathcal{A}'$ are the east and west points, at which the star makes



its transits over one of the wires, when this wire is north of the axis of collimation. But when the axis of the telescope is reversed, so as to bring this wire south of the axis of collimation, B and B' are the points of east and west transit.

Let

$h_n = A\,P\,Z = \frac{1}{2}\,(A\,P\,A')$

$= \frac{1}{2}$ the sidereal interval between the times of east and west transit, when the wire is north of the axis of collimation.

$h_s = B\,P\,Z = \frac{1}{2}$ the sidereal interval, when the wire is south of the axis of collimation.

$A\,S\,A'$ is the arc of a great circle joining A and A'.

$B\,S'\,B'$ is the arc of a great circle joining B and B'.

Each of these circles is perpendicular to $P\,Z\,M$.

Let $D =$ the star's declination.

$L_n =$ the declination of the point S.

$L_s =$ the declination of the point S'.

The right triangles $A\,P\,S$ and $B\,P\,S'$ give the following formulæ for determining L_n and L_s: —

$$\tan. L_n = \tan. D \sec. h_n,$$
$$\tan. L_s = \tan. D \sec. h_s;$$

or, when the star passes near the zenith, as it always should do in these observations, these equations give

$$\cos. h_n = \frac{\tan. D}{\tan. L_n},$$

$$\frac{1 - \cos. h_n}{1 + \cos. h_n} = \frac{\tan. L_n - \tan. D}{\tan. L_n + \tan. D},$$

$$\tan.^2 \tfrac{1}{2} h_n = \frac{\sin. (L_n - D)}{\sin. (L_n + D)},$$

$$\sin. (L_n - D) = \tan.^2 \tfrac{1}{2} h_n \,.\, \sin. (L_n + D),$$

and, in the same way,

$$\sin. (L_s - D) = \tan.^2 \tfrac{1}{2} h_s \,.\, \sin. (L_s + D);$$

and these two formulas are, in this case, to be preferred in computing the values of L_n and L_s. When the star passes very near the zenith, they are reduced to

$$L_n - D = \tfrac{1}{4} h_n^2 \sin. 1'' \sin. (L_n + D)$$
$$L_s - D = \tfrac{1}{4} h_s^2 \sin. 1'' \sin. (L_s + D).$$

In order to determine the declination of the point Z, which will be denoted by L, let

δi = the distance of the wire from the axis of collimation ; produce ZP to the horizon at H, so that ZH may be a quadrant. The right triangles HAS and PAS give, by Bowditch's rules for the solution of oblique spherical triangles,

$$\frac{\cos. HA}{\cos. AP} = \frac{\cos. HS}{\cos. PS},$$

or
$$\frac{\cos. (90^\circ - \delta i)}{\cos. (90^\circ - D)} = \frac{\cos. (90^\circ - L_n + L)}{\cos. (90^\circ - L_n)},$$

or
$$\frac{\sin. \delta i}{\sin. D} = \frac{\sin. (L_n - L)}{\sin. L_n}.$$

In the same way, the right triangles HBS' and PBS' give

$$\frac{\sin. \delta i}{\sin. D} = \frac{\sin. (L - L_s)}{\sin. L_s};$$

hence
$$\frac{\sin. (L_n - L)}{\sin. L_n} = \frac{\sin. (L - L_s)}{\sin. L_s},$$

and $$\frac{\sin.\,(L_n - L)}{\sin.\,(L - L_s)} = \frac{\sin.\,L_n}{\sin.\,L_s};$$

whence $$\frac{\sin.\,(L_n - L) - \sin.\,(L - L_s)}{\sin.\,(L_n - L) + \sin.\,(L - L_s)} = \frac{\sin.\,L_n - \sin.\,L_s}{\sin.\,L_n + \sin.\,L_s},$$

or $$\frac{\tan.\,[\frac{1}{2}\,(L_n + L_s) - L]}{\tan.\,\frac{1}{2}\,(L_n - L_s)} = \frac{\tan.\,\frac{1}{2}\,(L_n - L_s)}{\tan.\,\frac{1}{2}\,(L_n + L_s)},$$

and $$\tan.\,[\tfrac{1}{2}\,(L_n + L_s) - L] = \tan.^2\,\tfrac{1}{2}\,(L_n - L_s)\,\cot.\,\tfrac{1}{2}\,(L_n + L_s).$$

But L_n differs very little from L_s; and L is so near a mean between L_n and L_s, that it may be substituted for this mean, in the second member of this equation; whence

$$\tfrac{1}{2}\,(L_n + L_s) - L = \tfrac{1}{4}\,(L_n - L_s)^2 \sin.\,1''\,\cot.\,L,$$

or $$L = \tfrac{1}{2}\,(L_n + L_s) - \tfrac{1}{4}\,(L_n - L_s)^2 \sin.\,1''\,\cot.\,L.$$

The term $\frac{1}{4}\,(L_n - L_s)^2 \sin.\,1''\,\cot.\,L$, which may be denoted by $\delta\,L$, is then a small correction to be subtracted from the mean of the declinations of S and S', in order to obtain that of Z. It needs to be computed but once for each wire and star; for no changes in the place of the star and no errors of observation can perceptibly affect its value. The same remark is applicable with regard to the values of $L_n - L$ and $L - L_s$, that they need to be determined only once, and their values are given by the formulæ,

$$L_n - L = \tfrac{1}{2}\,(L_n - L_s) + \delta\,L,$$
$$L - L_s = \tfrac{1}{2}\,(L_n - L_s) - \delta\,L;$$

and they have been determined for each of the stars, except α Lyræ, by the mean of all the observations in which both the east and west transits of the star have been observed. The determination of these values is given in Table VI. The letters n and s, which are annexed in this table to L, denote the direction of the illuminated axis of the telescope, and their use differs, therefore, slightly from that of this explanation.

A different method of computation, and one which is more rapid in practice, has been applied to the reduction of the observations of α Lyræ.

The triangles APH and BPH give

$$\begin{aligned}\sin.\ \delta i &= \sin.\ D \cos.\ L - \cos.\ D \sin.\ L \cos.\ h_n \\ &= - \sin.\ D \cos.\ L + \cos.\ D \sin.\ L \cos.\ h_s\,;\end{aligned}$$

whence

$$\tan.\ D \cot.\ L = \tfrac{1}{2} (\cos.\ h_n + \cos.\ h_s).$$

But the right triangle PDZ gives, by putting

$$h = DPZ,$$
$$\cos.\ h = \tan.\ D \cot.\ L.$$

Hence

$$\begin{aligned}\cos.\ h &= \tfrac{1}{2} (\cos.\ h_n + \cos.\ h_s) \\ &= \cos.\ \tfrac{1}{2} (h_n + h_s) \cos.\ \tfrac{1}{2} (h_n - h_s).\end{aligned}$$

$$\cos.\ \tfrac{1}{2} (h_n - h_s) = \frac{\cos.\ h}{\cos.\ \tfrac{1}{2} (h_n + h_s)}$$

$$\frac{1 - \cos.\ \tfrac{1}{2} (h_n - h_s)}{1 + \cos.\ \tfrac{1}{2} (h_n - h_s)} = \frac{\cos.\ \tfrac{1}{2} (h_n + h_s) - \cos.\ h}{\cos.\ \tfrac{1}{2} (h_n + h_s) + \cos.\ h}$$

$$\tan.^2 \tfrac{1}{4} (h_n - h_s) = \tan.\ \tfrac{1}{2} [h - \tfrac{1}{2} (h_n + h_s)] \tan.\ \tfrac{1}{2} [h + \tfrac{1}{2} (h_n + h_s)].$$

But $h_s - h_n$ is very small, and h differs very little from $\frac{1}{2} (h_n + h_s)$; whence

$$h - \tfrac{1}{2} (h_n + h_s) = \tfrac{1}{8} (h_n - h_s)^2 \tan.\ 1'' \cot.\ h\,;$$

and the second member of this equation, which may be denoted by δh, is a correction which must be added to $\frac{1}{2} (h_n + h_s)$ to obtain h. And in the same way, the corrections for reducing h_n and h_s to h are obtained by the following formulæ: —

$$h_n - h = \tfrac{1}{2} (h_n - h_s) - \delta h,$$
$$h - h_s = \tfrac{1}{2} (h_n - h_s) + \delta h.$$

These corrections need be computed but once; and the computation of them for α Lyræ, from the mean of all the observations on those days on which the east and west transits were both observed, is contained in Table VII. The corrections of h for changes in the declination of the point Z, that is, for changes in the level, are obtained from the differential of the above value of cos. h, which is, if Dh and DL denote these corresponding changes,

$$\sin.\ h\ .\ D h = \frac{\tan.\ D}{\sin.^2 L}\ .\ D L.$$

This equation, divided by the value of cos. h, becomes

$$\tan. h \,.\, D h = \frac{D L}{\sin. L \,.\, \cos. L} = \frac{2 D L}{\sin. 2 L},$$

and will also answer well enough, for a star so high as α Lyræ, in computing the change of h, corresponding to a change $- D L$ of the declination.

When the value of h is found, that of L is readily determined by the formula

$$\sin. (L - D) - \tan.^2 \tfrac{1}{2} h \sin. (L + D),$$

which it will be convenient to compute for a mean value of h, and determine the corrections of L for another value of h, by the preceding formulæ between $D L$ and $D h$, in which sin. 2 L and tan. h may be regarded as constant.

This method of reduction, although exceedingly expeditious, cannot be applied to those stars which pass very near the zenith, because the observation of the time of transit of such a star over one of the wires is much more uncertain when the wire is south of the axis of collimation, than when it is north; that is, the value of h_s is less accurate than that of h_n. The values of h, therefore, and those of L, computed from h_s, will be less accurate than those computed from h_n, although the contrary should be the case; for it is obvious that the southern observations ought to have rather the advantage over the northern ones in the determination of the latitude. The observer will find, in fact, that if he undertake to reduce, by this method, his observations of a star which passes so near the zenith as not to make a transit over his most southern wires, which is the case with μ Ursæ Majoris and 8 Canum Venaticorum in this series, he will obtain most unsatisfactory results.

The value of L is, finally, the latitude of the place of observation, if the telescope is exactly in the prime vertical. But if the plane

of the telescope makes a small angle a, with the prime vertical, so that the zenith is at Z', instead of Z; and if $D h$ denotes the hour angle of $P Z$, while L_0 denotes the latitude; L_0 may be obtained from L by the solution of the right triangle $Z P Z'$, or by the formula

$$L_0 = L - (\tfrac{15}{2} D h)^2 \text{ sin. } 1'' \text{ sin. } 2 L.$$

The value of $D h$ may be determined from the transits of low stars, and is the difference between the times of transit of one of these stars over the true prime vertical and over the axis of collimation of the telescope. This value, as also that of a and of $L - L_0$, is computed in Table IX. The value of a is derived from the formula

$$a = 15 \, D h \text{ sin. } L.$$

The places of the stars were not taken from any of the published tables, but from all the observations which have been published at Greenwich, Edinburgh, and Cambridge, within the last ten years. The declinations are given in Table II., for the purpose of future revision. The values of L given by the different stars, with the means, are contained in Tables VIII. and X.

After this memoir was presented to the Academy, a note was received, through the kind attentions of Captain Beaufort, R. N., from the astronomer royal, Mr. Airy, in which he has liberally communicated the results of all the Greenwich observations upon the stars here observed, to the end of the year 1844. These observations induce me to increase the declinations, given in Table II., of α Lyræ, by 0″.10; of γ^1 Andromedæ, by $-$0″.01; of μ Ursæ Majoris, by $-$0″.14; and of 8 Canum Venaticorum, by 0″.18. These corrections are incorporated into the results of Table X.

TABLE I.

Time and Rate of Chronometer No. 2419.

Date.		Sid. Time. h.	m.	Chronometer slow. m.	s.	Rate during interval. s.
1844.	Dec. 12,	5	20	1	41.09	
	" 15,	6	0	1	42.70	— 0.52
	" 20,	0	30	1	46.83	— 0.86
	" 24,	2	00	1	48.74	— 0.46
	" 25,	2	15	1	49.55	— 0.81
	" 26,	2	45	1	47.78	+ 1.77
	" 29,	0	30	1	48.13	— 0.12
1845.	Jan. 2,	5	15	1	51.10	— 0.71
				Mean rate =		— 0.48

TABLE II.

Declinations of the Stars, computed from the Greenwich, Edinburgh, and Cambridge Observations.

Name of Star.	Mean Declination, for Jan. 1, 1845.	Apparent Declination, for Dec. 15.	Dec. 20.	Dec. 25.	Dec. 30.	Jan. 4.
	° ′ ″	″	″	″	″	″
α Lyræ . .	38 38 33.54	42.34	40.87	39.36	37.83	36.28
β Persei . .	40 21 15.27	24.97	25.43	25.83	26.15	26.41
γ^1 Andromedæ .	41 34 58.71	72.92	73.25	73.48	73.63	73.69
μ Ursæ Majoris	42 16 36.51	17.67	17.18	16.86	16.64	16.57
8 Canum Venaticorum	42 11 61.70	44.22	43.14	42.18	41.33	40.64

TABLE III.

Observations of the Level.

In the column of Observers, B¹ denotes W. C. Bond.
B² " G. P. Bond.*
G " Major Graham.

Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.	Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.
	d. h.		″	″	″	″	″		d. h.		″	″	″	″	″
B¹	Dec. 12 1¼	N.	93.0	93.0	0.00	—1.00	—1.08	B¹	Dec. 12 3	N.	92.0	93.0	0.50	0.00	—0.12
		S.	91.0	95.0	—2.00					S.	92.0	93.0	—0.50		
		N.	94.0	93 0	0.50	—1.25				N.	95.0	93.0	1.00	—0.25	
		S.	90.0	96.0	—3.00					S.	92.0	95.0	—1.50		
		N.	94.0	93.0	0.50	—1.00									
		S.	91·0	96.0	—2 50										

* I cannot refrain from thanking Mr. G. P. Bond for his valuable assistance in the reduction of the observations. It is due to him, also, to call attention to the fact, that all the observations upon 8 Canum Venaticorum were made by him, and that this star was his own selection. B. P.

TABLE III. — Continued.

Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.
	d. h.		″	″	″	″	″
B^1	Dec. 12 4	N.	94.0	94.0	0.00	0.00	−0.12
		S.	94.0	94.0	0.00		
		N.	94.0	95.0	−0.50	−0.25	
		S.	95.0	93.0	1.00		
B^1	12 4½	N.	95.0	95.0	0.00	0.00	0.00
		S.	96.0	96.0	0.00		
B^1	12 11¼	N.	98.0	102.0	−2.00	−1.00	−1.00
		S.	100.0	100.0	0.00		
B^2	14 1¾	N.	89.0	84.0	2.50	1.75	1.87
		S.	88.0	86.0	1.00		
		N.	90.0	84.0	3.00	2.00	
		S.	88.0	86.0	1.00		
B^1	14 3	N.	87.0	86.0	0.50	0.25	0.37
		S.	87.0	87.0	0.00		
		N.	88.0	86.0	1.00	0.50	
		S.	87.0	87.0	0.00		
B^2	14 4½	N.	91.0	83.0	4.00	1.75	1.62
		S.	86.0	87.0	−0.50		
		N.	91.0	83.0	4.00	1.50	
		S.	86.0	88.0	−1.00		
B^2	15 20¼	N.	90.0	89.0	0.50	0.25	0.25
		S.	90.0	90.0	0.00		
B^2	16 1¼	S.	91.3	89.0	1.15	0.70	0.56
		N.	90.7	90.2	0.25		
		S.	91.7	89.0	1.35	0.42	
		N.	90.0	91.0	−0.50		
		S.	91.7	89.0	1.35	0.57	
		N.	90.0	90.4	−0.20		
B^2	16 1¾	N.	91.0	89.5	0.75	1.12	1.02
		S.	92.0	89.0	1.50		
		N.	90.0	90.8	−0.40	0.92	
		S.	92.5	88.0	2.25		
B^1	16 3	N.	91.8	90.3	0.75	0.00	−0.06
		S.	90.5	92.0	−0.75		
		N.	91.0	91.0	0.00	−0.12	
		S.	91.0	91.5	−0.25		
B^2	16 4½	N.	92.0	93.0	−0.50	−1.00	−1.06
		S.	91.0	94.0	−1.50		
		N.	92.0	93.0	−0.50	−1.12	
		S.	91.0	94.5	−1.75		
B^1	16 16¾	N.	94.5	94.5	0.00	0.00	−0.02
		S.	94 3	94.3	0.00		
		N.	94.0	94.2	−0.10	−0.05	
		S.	94.0	94.0	0.00		
B^2	17 1¼	N.	95.0	92.5	1.25	0.12	0.06
		S.	93.0	95.0	−1.00		
		N.	95.0	93.0	1.00	0.00	
		S.	93.0	95.0	−1.00		
B^2	17 1¾	N.	94.0	94.0	0.00	0.00	0.00
		S.	94.5	94.5	0.00		
B^1	17 3	N.	96.7	94.0	1.35	0.47	0.13
		S.	95 0	95.8	−0.40		
		N.	96.0	95.0	0.50	0.00	
		S.	95.0	96.0	−0.50		
		N.	96.0	95.0	0.50	−0.07	
		S.	94.7	96.0	−0.65		
B^2	17 10¼	N.	95.0	100.0	−2.50	−0.40	−0.40
		S.	99.8	96.4	1.70		

Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.
	d. h.		″	″	″	″	″
B^2	Dec. 17 10¾	N.	100.5	98.4	1.05	−0.10	−0.65
		S.	97.0	102.0	−1.25		
		N.	100.0	98.5	0.75	−1.00	
		S.	96.5	102.0	−2.75		
		N.	99.5	99.5	0.00	−0.85	
		S.	97.6	101.0	−1.70		
B^1	18 1¼	N.	96.0	97.0	−0.50	−0.25	−0.21
		S.	96.5	96.5	0.00		
		N.	96.0	97.0	−0.50	−0.37	
		S.	96.5	97.0	−0.25		
		N.	97.0	98.0	−0.50	0.00	
		S.	98.0	97.0	0.50		
B^1	18 1¾	N.	97.3	98.0	−0.35	0.00	−0.07
		S.	98.0	97.3	0.35		
		N.	97.3	98.0	−0.35	−0.17	
		S.	98.0	98.0	0.00		
		N.	97.5	98.0	−0.25	−0.05	
		S.	98.3	98.0	0.15		
B^1	18 3	N.	97.0	100.5	−1.75	−0.62	−0.85
		S.	99.3	98.3	0 50		
		N.	97.0	101.0	−2.00	−1.00	
		S.	99.0	99.0	0.00		
		N.	97.3	101.0	−1.85	−0.92	
		S.	99.3	99.3	0.00		
B^1	18 16¾	N.	95.0	95.0	0.00	−0.50	−0.58
		S.	94.0	96.0	−1.00		
		N.	95.0	95.0	0.00	−0.75	
		S.	93.5	96.5	−1.50		
		N.	95.0	95.0	0.00	−0.50	
		S.	94.0	96.0	−1.00		
B^1	18 20½	N.	95.0	96.0	−0.50	−0.75	−0.75
		S.	95.0	97.0	−1.00		
		N.	95.0	96.0	−0.50	−0.75	
		S.	94.5	96.5	−1.00		
B^2	20 1¼	N.	93.5	96.0	−1.25	−0.05	−0.14
		S.	96.1	93.8	1.15		
		N.	93.5	97.0	−1.75	−0.23	
		S.	97.0	94.4	1.30		
B^2	20 1¾	N.	94.8	98.0	−1.60	−0.07	−0.07
		S.	98.1	95.0	1.55		
B^2	20 3½	S.	97.8	96.5	0.65	−0.92	−0.83
		N.	96.0	101.0	−2.50		
		S.	99.8	98.0	0.90	−0.75	
		N.	96.2	101.0	−2.40		
B^2	20 4½	N.	96.0	103.0	−3.50	−1.75	−1.31
		S.	100.0	100.0	0.00		
		N.	97.5	103.0	−2.75	−0.87	
		S.	101.5	99.5	1.00		
B^2	20 16¾	N.	97.2	105.0	−3.90	−1.95	−1.85
		S.	101.0	101.0	0.00		
		N.	97.5	104.5	−3.50	−1.75	
		S.	101.0	101.0	0.00		
G	23 16¾	N.	90.4	86.4	2.00	0.50	0.41
		S.	87.5	89.5	−1.00		
		N.	90.0	87.2	1.40	0.27	
		S.	87.5	89.2	−0.85		
		N	89.4	87.0	1.20	0.47	
		S.	88.0	88.5	−0.25		

TABLE III. — Continued.

Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.
	d. h.		″	″	″	″	″
G	Dec. 23 20½	N.	86.3	85 2	0.55	−0.07	0.02
		S.	84.8	86.2	−0.70		
		N.	85.8	85.0	0.40	0.12	
		S.	85.0	85.3	−0.15		
G	24 2	N.	87.0	89.0	−1.00	0.00	0.07
		S.	89.0	87.0	1.00		
		N.	87.7	88.3	−0.30	0.15	
		S.	88.4	87.2	0.60		
G	24 16¾	N.	87.6	89.2	−0.80	−0.45	−0.30
		S.	87.8	88.0	−0.10		
		N.	87.0	87.5	−0.25	−0.25	
		S.	86.5	87.0	−0.25		
		N.	86.1	86.3	−0.10	−0.20	
		S.	85.4	86.0	−0.30		
G	25 2	N.	85.6	83.8	0.90	0.05	0.15
		S.	83.2	84.8	−0.80		
		N.	84.3	83 0	0.65	0.25	
		S.	83.2	83.5	−0.15		
G	25 4½	N.	84.8	83.6	0.60	0.12	0.22
		S.	83.6	84.3	−0.35		
		N.	85.0	83.3	0.85	0.22	
		S.	83.0	83.8	−0.40		
		N.	83.8	82 0	0.90	0.32	
		S.	82.5	83.0	−0.25		
G	26 2	N.	82 6	74.7	3.95	0.97	0.87
		S.	76.3	80.3	−2.00		
		N.	82.0	74.3	3.85	1.00	
		S.	76.3	80.0	−1.85		
		N.	81.5	74.5	3.50	0.65	
		S.	75.8	80.2	−2.20		
B²	28 11	N.	103.5	103.7	−0.10	−0.82	−0.99
		S.	102.4	105.5	−1.55		
		N.	103.5	104.9	−0.70	−1.17	
		S.	102.9	106.2	−1.65		
		N.	104.5	105.2	−0.35	−0.97	
		S.	103.2	106.4	−1.60		
B²	28 13¼	N.	103.5	103.8	−0.15	−1.65	−1.58
		S.	101.5	107.8	−3.15		
		N.	105.8	105 6	0.10	−1.52	
		S.	103.2	109.5	−3.15		
B¹	28 16¾	N.	102.5	105.5	−1.50	−1.00	−1.25
		S.	103.0	104.0	−0.50		
		N.	102.0	105.0	−1.50	−1.50	
		S.	102.0	105.0	−1.50		
		N.	102.0	105.0	−1.50	−1.25	
		S.	102.5	104.5	−1.00		
B¹	28 20½	N.	99.5	100.2	−0.35	−1.42	−1.32
		S.	97.5	102.5	−2.50		
		N.	99 5	99.5	0.00	−1.25	
		S.	96.5	101.5	−2.50		
B²	29 11	N.	96.7	96.5	0.10	−0.70	−0.44
		S.	95.0	98.0	−1.50		
		N.	97.5	96.0	0.75	−0.37	
		S.	95.0	98.0	−1.50		
		N.	98.0	95.0	1.50	−0.25	
		S.	94.0	98.0	−2.00		
B²	30 9½	N.	83.2	88.7	−2.75	0.37	0.37
		S.	89.5	82.5	3.50		

Observer.	Date.	Crossed End.	N.	S.	Mean.	North end of axis too high.	Mean.
	d. h.		″	″	″	″	″
B²	Dec. 30 10¼	N.	84.9	87.1	−1.10	1.10	0.85
		S.	89.3	82 7	3.30		
		N.	84.5	87.9	−1.70	0.60	
		S.	89.1	83.3	2.90		
B²	30 10¾	S.	89.4	84.2	2.60	0.25	0.25
		N.	85.2	89.4	−2.10		
B²	30 11¾	N.	90.9	83.1	3 90	0.15	0.15
		S.	83 5	90.7	−3.60		
B²	30 12½	S.	86.0	88.5	−1.25	1.02	0.77
		N.	90 6	84.0	3.30		
		S.	85.8	88.4	−1.30	0.52	
		N.	89 6	84.9	2.35		
B²	30 13	S.	85.0	89.6	−2.30	0.12	0.12
		N.	89.7	84.6	2.55		
B²	Jan. 1 9½	N.	88.0	83.5	2.25	−0.25	−0.25
		S.	83.2	88.7	−2.75		
B²	1 10	S.	84.7	90.0	−2.65	−0.20	−0.36
		N.	90.0	85.0	2.25		
		S.	84.6	90.3	−2.85	−0.52	
		N.	89.6	86.0	1.80		
B²	1 10¾	S.	83.0	94.3	−5.65	−2.42	−2.50
		N.	89.6	88.0	0.80		
		N.	90 0	88.5	0.75	−2.57	
		S.	83.6	95.4	−5.90		
		N.	91.0	89.4	0.80	−2.50	
		S.	84.8	96.4	−5 80		
B¹	1 20½	N.	96.0	92.0	2.00	−0.75	−1.12
		S.	85.0	102.0	−3.50		
		N.	96.0	92.0	2 00	−1.25	
		S	84.0	103.0	−4.50		
		N.	95.0	92.0	1.50	−1.37	
		S.	84.0	102.5	−4.25		
B¹	1 1¼	N.	91.0	98.0	−3.50	−2.75	−2.75
		S.	92.0	96.0	−2.00		
		N.	91.0	98.0	−3.50	−2.75	
		S.	92.0	96.0	−2.00		
		N.	91.0	98.0	−3.50	−2.75	
		S.	92.0	96 0	−2.00		
B¹	1 3	N.	93.0	98.0	−2.50	−3.12	−3.04
		S.	91.5	99.0	−3.75		
		N.	92.0	98.0	−3.00	−3.00	
		S.	92.0	98.0	−3.00		
		N.	92.0	98.0	−3.00	−3.00	
		S.	92.0	98.0	−3.00		
B²	5 9½	N.	66.3	77.3	−5.50	−4.20	−4.12
		S.	68.7	74.5	−2.90		
		S.	68.8	74.3	−2.85	−4.05	
		N.	66.8	77.3	−5.25		
B²	5 10½	N.	65.0	78.0	−6.50	−4.22	−4.01
		S.	69.9	73.8	−1.95		
		N.	66.5	77.7	−5.60	−3.80	
		S.	70.3	74.3	−2.00		
		S.	73.0	74.3	−0.65	−4.00	
		N.	67.0	81.7	−7.35		
B²	5 11½	N.	67.5	87.2	−7.85	−4.17	−4.17
		S.	78.0	77.0	0.50		
B²	5 12¼	N.	68.0	87.2	−9.60	−4.55	−4.55
		S.	78.0	77.0	0.50		
B²	5 13¼	S.	80.0	78.2	0.90	−4.80	−4.85
		N.	69.0	90.0	−10.50		
		S.	81.0	79.0	1.00	−4.90	
		N.	69.0	90.6	−10.80		

TABLE IV.

Observations of the Transits of Stars for determining the Latitude.

Name of Star.	Observer.	Date.	Ill. end of axis.	Transit.	Time of transit over wire. A.	B.	C.	D.	E.	F.	G.	Error of Level, N. end too high.	Ex. Th.
					h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″	°
κ Lyræ.	B^2	Dec. 15	N.	W.	20			25 14.2				0.25	
"	B^1	16	S.	E.	16 38 11.0	37 3.0	35 55.2	34 47.3	33 40.2	32 32.5		—0.02	32
"	B^1	16	S.	W.	20 21 49.7	22 58.8	24 6.8	25 14.0	26 21.3	27 27.7	28 33.2	—0.02	
"	B^1	19	N.	E.	16 31 24.2	32 30.0	33 36.0	34 43.1	35 50.8	36 58.8	38 7.8	—0.58	27
"	B^1	19	N.	W.	20 28 29.2	27 23.0	26 17.2	25 10.5	24 2.8	22 55.0	21 46.3	—0.75	
"	B^2	20	S.	E.	16 38 5.6	36 57.0	35 48.8	34 41.4	33 34.2	32 28.0	31 22.2	—1.85	8
"	G	23	S.	E.	16 38 5.8	36 57.2	35 49.0	34 42.0	33 34.5	32 28.2	31 22.5	0.41	
"	G	23	S.	W.	20 21 45.0	22 54.0	24 1.5	25 9.0	26 16.2	27 22.5	28 28.1	—0.02	
"	G	24	N.	E.	16 31 22.0	32 28.4	33 34.5	34 40.9	35 48.7	36 56.8	38 5.4	—0.30	
"	B^1	29	N.	E.	16 31 22.3	32 28.5	33 34.3	34 41.2	35 47.1	36 55.2	37 5.5	—1.25	10
"	B^1	29	N.	W.	20 28 28.3	27 22.5	26 18.4		24 2.0			—1.32	
"	B^1	Jan. 2	S.	E.	20 21 44.3	22 54.0	24 1.2	25 8.4	16 15.2	27 21.3		—1.12	21
β Persei.	B^2	Dec. 14	N.	E.	1 26 35.0	28 3.0	29 31.0	31 1 2	32 33.2	34 6.8	35 42.4	1.87	
"	B^2	14	N.	W.	4 26 23.2	24 55.6	23 26.9	21 57.0	20 24.7	18 51.5	17 16.2	1.62	
"	B^2	16	S.	E.	1 35 41.2	34 5.3	32 31.6	31 0.0	29 29.5	28 0.5	26 33.9	0.79	
"	B^2	16	S.	W.	4 17 17.3	18 52.8	20 25.8	21 57.0	23 28.0	24 57.2	26 25.0	—1.06	
"	B^2	17	S.	E.	1 35 40.5	34 4.7	32 32.5	31 0.0	29 29.2	28 1.0	26 33.3	0.03	
"	B^1	18	N.	E.	1 26 33.0	28 0.5	29 29.0	30 58.2	32 30.0	34 5.0	35 40.0	—0.14	
"	B^2	20	N.	E.	1 26 30.7	27 58.7	29 26.8	30 57.0	32 29.0	34 2.5	35 38.0	—0.10	
"	B^2	20	N.	W.	4 26 20.0	24 52.2	23 23.7	21 53.2	20 21.5	18 48.0	17 13.0	—1.31	
"	G	23	S.	E.	1		32 27.3	30 55.0	29 25.0	27 56.5	26 29.0		
"	G	24	S.	E.	1 35 35 6	34 0.0	32 27.0	30 55.3	29 24.3	27 56.0	26 28.3	0.07	30
"	G	25	N.	E.	1 26 29.0	27 57.0	29 25.0	30 55.5	32 27.8	34 1.5	35 36.5	0.15	37
"	G	25	N.	W.	4 26 17.8	24 49.5	23 21.4	21 50.8	20 19.0	18 45.5	17 10.0	0.22	
"	G	26	S.	E.	1 35 36.5	34 0.5	32 27.5	30 55.6	29 24.5	27 56.5	26 28.5	0.87	
"	G	26	S.	W.	4 17 11.0	18 46.0	20 19.6	21 51.0				0.87	41
γ^1 Andromedæ.	B^1	12	N.	E.	0		56 37.3	58 58.9	61 28.0	64 4.0	66 49.6	—1.08	20
"	B^1	12	N.	W.	2 53 28.8	51 16.7	49 0.7	46 38.5	44 8.5	41 33.2	38 48.0	—0.12	
"	B^1	14	N.	E.	0			58 58.0	61 26.8	64 3.7	66 47.6	1.87	30
"	B^1	14	N.	W.	2 53 26.6	51 13.8	48 58.2	46 37.0	44 6.7	41 30.5	38 46.5	0.37	
"	B^1	16	S.	E.	0 66 47.0	64 0.9	61 25.0	58 55.9	56 34.4	54 17.7	52 6.3	1.02	23
"	B^1	16	S.	W.	2 38 47.5	41 33.6	44 8.4	46 37.0	49 0.0	51 16.9	53 27.9	—0.06	
"	B^2	17	S.	E.	0 66 45.5	63 59.5	61 24.7	58 55.7	56 33.4	54 17.4	52 6.1	0.03	19
"	B^1	17	S.	W.	2 38 47.2	41 33.3	44 9.0	46 37.0	49 0.7	51 17.0	53 27.0	0.13	
"	B^1	18	N.	E.	0 52 5.2	54 17.2	56 33.4	58 54.2	61 25.0	64 0.0	66 44.3	—0.14	15
"	B^1	18	N.	W.	2 53 25.3	51 12.5	48 56.0	46 34.0	44 7.0	41 30.2	38 44.3	—0.46	
"	B^2	20	N.	E.	0 52 3.0	54 15.0	56 31.3	58 53.0	61 22.8	63 58.8	66 43.0	—0.10	19
"	B^2	20	N.	W.	2 53 22.3	51 11.0	48 54.8	46 33.0	44 3.3	41 27.7	38 43.0	—0.45	
"	G	24	S.	E.	0 66 40.8	63 55.7	61 19.0	58 51.0	56 28.5	54 12.2	52 0.0	0.07	
"	G	25	N.	E.	0 52 1.0	54 13.5	56 29.7	58 50.9	61 21.5	63 57.0	66 42.0	0.15	
"	G	25	N.	W.	2 53 20.5	51 8.0	48 52.5	46 30.0	44 0.8	41 24.2		0.22	
"	G	26	S.	E.	0 66 41.0	63 55.0	61 20.6	58 51.7	56 29.4	54 12.7	52 2.5	0.87	45
"	G	26	S.	W.	2 38 40.5	41 26.7	44 1.5	46 30.7	48 53.2	51 9.5	53 20.7	0.87	42
"	B^1	Jan. 2	S.	E.	0 66 35.5	63 50.0	61 15.2	58 46.0	56 22.8	54 7.2	51 56.0	—2.75	15
"	B^1	2	S.	W.	2 38 41.8	41 27.2	43 2.5	46 30.2	48 53.4	51 9.8	53 20.5	—3.04	
μ Ursæ Majoris	B^1	Dec. 12	N.	E.	9			51 25.0				—1.00	
"	B^2	17	S.	E.	9			51 23.0	45 39.5	40 59.5	36 59.5	—0.40	20
"	B^2	17	S.	W.	10			31 27.5	37 11.0	41 49.5	45 52.5	—0.52	
"	B^2	28	N.	E.	9		45 42.3	51 23.0	59 37.5			—0.99	3
"	B^2	28	N.	W.	10 45 50.0	41 45.5		31 27.0	23 8.5			—0.99	
"	B^2	29	S.	E.	9		59 26.5	51 17.6	45 34.2	40 56.0		—0.44	19
"	B^1	29	S.	W.	10		23 16.2	31 26.0	37 8.7			—0.44	
"	B^2	30	N.	E.	9	41 0.5	45 38.7	51 23.5	59 40.5			0.60	32
"	B^2	30	N.	W.	10 45 45.5	41 42.5	37 2.5	31 20.0	23 1.0			0.55	
"	B^2	Jan. 1	S.	E.	9		59 26.5	51 15.5	45 32.5	40 53.0		—1.40	20
"	B^2	1	S.	W.	10		23 10.0	31 22.5	37 6.0			—1.40	
"	B^2	5	S.	E.	9		59 22.5	51 13.0	45 29.7	40 50.5	36 48.5	—4.12	24
"	B^2	5	S.	W.	10			31 25.3	37 8.5	41 47.5	45 49.5	—4.12	
8 Canum venaticorum.	B^2	Dec. 28	N.	E.	11 46 22.0		53 56.5	58 33 5	64 10.5	72 6.0		—0.99	
"	B^2	28	N.	W.	12 62 55.5	59 20.0		50 45.0	45 6.4			—1.58	
"	B^2	30	N.	E.	11 46 22.3	49 58.5	35 58.5	58 33.0	64 12 8	72 8.0		0.46	
"	B^2	30	N.	W.	12 62 52.5	59 15.5	55 16.5	50 41.0	45 1.5	37 5.0		0.45	
"	B^2	Jan. 5	S.	E.	11	71 49.0	64 0.5	58 25.0	53 48.5	49 49 0	46 14.0	—4.36	
"	B^2	5	S.	W.	12	37 24.5	45 9.5	50 47.0	55 23 0	59 23.2	62 57.0	—4.70	

TABLE V.

Computation of the Intervals of the Wires.

1. *From Observations of α Lyræ.*

Observer.	Date.	Ill. end of axis.	Transit.	Interval of Passage between Wire D and Wire A.	B.	C.	E.	F.	G.
				s.	s.	s.	s.	s.	s.
B^1	Dec. 16	S.	E.	203.7	135.7	67.9	67.1	134.8	
B^1	16	S.	W.	204.3	135.2	67.2	67.3	133.7	199 2
B^2	20	S.	E.	204.2	135.6	67.4	67.2	133.4	199.2
G	23	S.	E.	203.8	135.2	67.0	67.5	133.8	199.5
G	23	S.	W.	204.0	135.0	67.5	67.2	133.5	199.1
B^1	Jan. 2	S.	E.	204 1	134.4	67.2	66.8	132.9	
Mean		S.		204.02	135.18	67.37	67.18	133.68	199.25
B^1	Dec. 19	N.	E.	198.9	133.1	67.1	67.7	135.7	204.7
B^1	19	N.	W.	198 7	132.5	66.7	67.7	135 5	204.2
G	24	N.	E.	198.9	132.5	66.4	67.8	135.9	204.5
B^1	29	N.	E.	198.9	132.7	66.9	65.9	134.0	204.3
Mean		N.		198.85	132.70	66.78	67.18	135.18	204.42
2. *From Observations of β Persei.*									
B^2	Dec. 16	S.	E.	281.2	185.3	91.6	90.5	179.5	266.1
B^2	16	S.	W.	279.7	184 2	91.2	91.0	180.2	268.0
B^2	17	S.	E.	280.5	184.7	92 5	90.8	179.0	266.7
G	23	S.	E.			92.3	90.0	178.5	266.0
G	24	S.	E.	280.3	184.7	91.7	91.0	179.3	267.0
G	26	S.	E.	280.9	184.9	91.9	91.1	179.1	267.1
G	26	S.	W.	280.0	185.0	91.4			
Mean		S.		280.43	184.80	91.80	90.73	179.27	266.82
B^2	Dec. 14	N.	E.	266.2	178.2	90.2	92.0	185.6	281.2
B^2	14	N.	W.	266 2	178.6	89.9	92.3	185.5	280.8
B^1	18	N.	E.	265.2	177.7	89.2	91.8	186.8	281.8
B^2	20	N.	E.	266.3	178.3	90.2	92.0	185.5	281.0
B^2	20	N.	W.	266.8	179.0	90.5	91 7	185.2	280.2
G	25	N.	E.	266.5	178.5	90.5	92.3	186.0	281.0
G	25	N.	W.	267.0	178.7	90.6	91 8	185.3	280.8
Mean		N.		266.31	178.43	90.16	91.99	185.70	280.97
3. *From Observations of γ^1 Andromedæ.*									
B^1	Dec. 16	S.	E.	471.1	305.0	149.1	141.5	278.2	409.6
B^1	16	S.	W.	469.5	303.4	148.6	143.0	279.9	410 9
B^2	17	S.	E.	469.8	303.8	149.0	142 3	278.3	409.6
B^1	17	S.	W.	469 8	303.7	148.0	143.7	280.0	410.0
G	24	S.	E.	469.8	304.7	148.0	142.5	278.8	411.0
G	26	S.	E.	469.3	303.3	148.9	142.3	279.0	409.2
G	26	S.	W.	470.0	304.0	149.2	142.5	278.8	410.0
B^1	Jan. 2	S.	E.	469.5	304.0	149.2	143.2	278.8	410.0
B^1	2	S.	W.	468.4	303.0	147.7	143.2	279.6	410.3
Mean		S.		469.69	303.86	148.63	142 69	279 04	410.07
B^1	Dec. 12	N.	E.			141.6	149.1	305.1	470.7
B^1	12	N.	W.	410.3	278.2	142.2	150.0	305.3	470.5
B^1	14	N.	E.				148 8	305.7	469.6
B^1	14	N.	W.	409.6	276.8	141.2	150.3	306.5	470.5
B^1	18	N.	E.	409.0	277.0	140.8	150.8	305.8	470.1
B^1	18	N.	W.	411.3	278.5	142.0	147.0	303.8	469.7
B^2	20	N.	E.	410.0	278.0	141.7	149.8	305.8	470.0
B^2	20	N.	W.	409.3	278.0	141.8	149 7	305.3	470 0
G	25	N.	E.	409.9	277.4	141.2	150.6	306.1	471.1
G	25	N.	W.	410.5	278.0	142.5	149.2	305.8	
Mean		N.		409.96	277.74	141 67	149.53	305.52	470 24

TABLE V. — Continued.

4. *From Observations of μ Ursæ Majoris.*

Observ-er.	Date.	Ill. end of axis.	Transit.	Interval of Passage between Wire D and Wire A.	B.	C.	E.	F.	G.
				s.	s.	s.	s.	s.	s.
B^2	Dec. 17	S.	E.				343.5	623.5	863.5
B^2	17	S.	W.				343.5	622.0	865.0
B^2_1	29	S.	E.			488.9	343.4	621.6	
B^1	29	S.	W.			489.8	342.7		
B^2	Jan. 1	S.	E.			491.0	343.0	622 5	
B^2	1	S.	W.			492.5	343.5		
B^2	5	S.	E.			489.5	343.3	622.5	864.5
B^2	5	S.	W.				343.2	622.2	864.2
Mean		S.				490 34	343.26	622.38	864.30
B^2	Dec. 28	N.	E.			340.7	494.5		
B^2	28	N.	W.	863.0	618.5		498.5		
B^2	30	N.	E.		623.0	344.8	497.0		
B^2	30	N.	W.	865 5	622.5	342.5	499.0		
Mean		N.		864.25	621.33	342.67	497.25		

5. *From Observations of* 8 *Canum Venaticorum.*

Observ-er.	Date.	Ill. end of axis.	Transit.	A.	B.	C.	E.	F.	G.
B^2	Jan. 2	S.	E.		804.0	335.5	276.5	516 0	731.0
B^2	2	S.	W.		802.5	337.5	276.0	516.2	730.0
Mean		S.			803.25	336.50	276.25	516.10	730.50
B^2	Dec. 28	N.	E.	731.5		277.0	337.0	812.5	
B^2	28	N.	W.	730.5	515.0		338.6		
B^2	30	N.	E.	730.7	514.5	274.5	339.8	815.0	
B^2	30	N.	W.	731.5	514.5	275.5	339.5	816.0	
Mean		N.		731.05	514.67	275.67	338.72	814.50	

Values of the Intervals between the Wires.

Name of Star.	Ill. end of Axis.	Equatorial Interval between Wire D and Wire A.	B.	C.	E.	F.	G.
		s.	s.	s.	s.	s.	s.
α Lyræ	S.	51.05	33.98	17.01	17.12	34 21	51.21
"	N.	51.10	33.96	17.02	16.97	33.98	51.15
β Persei	S.	51.11	33.99	17.03	17.12	34.11	51.17
"	N.	51.07	33.94	17.01	17.07	34.15	51.21
γ^1 Andromedæ	S.	51.18	34.01	17.05	17.11	34.13	51.11
"	N.	51.10	33.96	16.98	17.15	34.18	51.23
μ Ursæ Majoris	S.			17.00	17.08	34.09	51.11
"	N.	51.11	34.02	17.04	17 18		
8 Canum Venaticorum	S.		33.98	17.07	17.07	34.12	51.11
"	N.	51.16	34.02	17.03	17.17	34.29	
Mean		51.11	33.98	17.02	17.10	34.14	51.16
By Micrometer			34.34	17.16	17.09	34.17	51.16

TABLE VI.

Determination of the Constants for the Computation of the Latitude.

1. *For β Persei.*

Observer.	Date.	Ill. end of axis.	Interval of Passage from E. to W. Transit over Wire A.	B.	C.	D.	E.	F.	G.	Seconds of Dec. + lev. corr.
			h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″
B^2	Dec. 16	S.	2 41 36.1	44 47.5	47 54.2	50 57.0	53 58.5	56 56.7	59 51.1	23.83
G	26	S.	34.5	45.5	52.1	55.4				25.66
Mean		S.	2 41 35.30	44 46.50	47 53.15	50 56.20	53 58.50	56 56.70	59 51.10	24.74
Val. of $L_s - D$			1° 48′ 9″.02	52′ 34″.55	56′ 58″.90	61′ 23″.68	65′ 52″.65	70′ 20″.67	74′ 47″.93	
Corresponding seconds of lev. and dec.			24.74	24.74	24.74	24.74	23.83	23.83	23.83	
			h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″
B^2	Dec. 14	N.	2 59 48.2	56 52.6	53 55.9	50 55.8	47 51.5	44 44.7	41 33.8	25.52
B^2	20	N.	49.3	53.5	56.9	56.2	52.5	45.5	35.0	23.43
G	25	N.	48.8	52.5	56.4	55.3	51.2	44.0	33 5	24.90
Mean		N.	2 59 48.77	56 52.87	53 56.40	50 55.77	47 51.73	44 44.73	41 34.10	24.62
Val. of $L_n - D$			1° 74′ 44″.36	70′ 14″.91	65′ 49″.54	61′ 23″.05	56′ 56″.88	52′ 31″.46	48′ 7″ 38	
$L_n - D$ reduced to lev. and dec. of $L_s - D$			1 74 44.24	70 14.79	65 49.42	61 22.93	56 56.67	52 31.25	48 7.17	
$\frac{1}{2}(L_n \backsim L_s)$			13 17.61	8 50.12	4 25.26	0.38	4 27.99	8 54.71	13 20.38	
$\frac{1}{2}(L_n + L_s) - L$			3.37	1.49	0.37	0.00	0.37	1.49	3.37	
$L_s \backsim L$			13 14.24	8 48.63	4 24.89	0.38	4 28.36	8 56.20	13 23.75	
$L_n \backsim L$			13 20.98	8 51.61	4 25.63	0.38	4 27.62	8 53.22	13 17.01	

2. *For γ^1 Andromedæ.*

Observer.	Date.	Ill. end of axis.	A.	B.	C.	D.	E.	F.	G.	Seconds of Dec. + lev. corr.
			h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″
B^1	Dec. 16	S.	1 31 60.5	37 32.7	42 43.4	47 41.1	52 25.6	56 59.2	61 21.6	13.74
B^1_2	17	S.	61.1	33.8	44.3	41.3	27.3	59.6	20.9	13.42
G	26	S.	59.5	31.7	40.9	39.0	23.8	56.8	18.2	14.67
B^1	Jan. 2	S.	66.3	37.2	47.3	44.2	30.6	62.6	24.5	11.06
Mean		S.	1 32 1.85	37 33.85	42 43.98	47 41.40	52 26.8	56 59.55	61 21.30	13.22
Val. of $L_s - D$			34′ 40″.43	39′ 0″.41	43′ 17″.33	47′ 36″.87	51′ 57″.95	56′ 18″.41	60′ 38″.59	
			h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″
B^1	Dec. 12	N.	1		52 23.4	47 39.6	42 40.5	37 29.2	31 58.4	12.41
B^1	14	N.				39.0	39.9	26.8	58.9	14.26
B^1	18	N.	61 20.1	56 55.3	22.6	39.8	42.0	30.2	60.0	13.11
B^2	20	N.	19.3	56.0	22.5	40.0	40.5	28.9	60.0	13.26
G	25	N.	19.5	54.5	22.8	39.1	39.3	27.2		13.91
Mean		N.	1 61 19.63	56 55.27	52 22.82	47 39.50	42 40.44	37 28.46	31 59.32	13.39
Val. of $L_n - D$			60′ 36″.89	56′ 14″25	51′ 54″.22	47′ 35″.24	43′ 14″.45	38′ 56″06	34′ 38″.50	
Corresponding seconds of lev. and dec.			13.43	13.43	13.17	13.39	13.39	13.39	13.26	
$L_n - D$ reduced to lev. and dec. of $L_s - D$			60 37.10	56 14.46	51 54.17	47 35.41	43 14.62	38 56.23	34 38.54	
$\frac{1}{2}(L_n \backsim L_s)$			12 58.34	8 37.02	4 18 42	0.73	4 21.66	8 41.09	13 0.02	
$\frac{1}{2}(L_n + L_s) - L$			3.24	1.44	0.36	0.00	0.36	1.44	3.24	
$L^s \backsim L$			12 55.10	8 35.58	4 18.06	0.73	4 22.02	8 42.53	13 3.26	
$L_n \backsim L$			13 1.58	8 38.46	4 18.78	0.73	4 21.30	8 39.65	12 56.78	

TABLE VI. — Continued.

3. *For μ Ursæ Majoris.*

Observer.	Date.	Ill. end of axis.	Interval of Passage from E. to W. Transit over Wire A.	B.	C.	D.	E.	F.	G.	Seconds of Dec. + lev. corr.
					m. s.	m. s.	m. s.	m. s.	m. s.	″
B^2	Dec. 17	S.				40 4 5	51 31.5	60 50.0	68 53.0	17.01
B^2_1	29	S.			23 49.7	8.4	34.5			16.22
B^2	Jan. 1	S.			43.5	7.0	33.5			15.57
B^2	5	S.				12 3	38.8	57.0	61.0	12.50
Mean		S.			23 46.60	40 8.05	51 34.58	60 53.50	68 57.00	15.32
Val. of $L_s - D$					2′ 18″.20	6′ 34″.12	10′ 51″.35			
Corresponding seconds of lev. and dec.					15.90	15.32	15.32			
			/	m. s.	m. s.	m. s.	m. s.			″
B^2	Dec. 28	N.				39 64.0	23 31.0			15.71
B^2	30	N.		60 42 0	51 23.8	56.5	20.5			17.20
Mean		N.		60 42.00	51 23.80	40 0.25	23 25.75			16.46
Val. of $L_n - D$					10′ 46″.96	6′ 31″.56	2′ 14″.18			
Corresponding seconds of lev. and dec.					17.20	16.46	16.46			
$L_n - D$ reduced to lev. and dec. of $L_s - D$					10 48.26	6 32.70	2 15.32			
$\frac{1}{2}(L_n \backsim L_s)$					4 15.03	0.71	4 18.01			
$\frac{1}{2}(L_n + L_s) - L$					0.35	0.00	0.35			
$L_s \backsim L$					4 14.68	0.71	4 18.36			
$L_n \backsim L$					4 15.38	0.71	4 17.66			

4. *For 8 Canum Venaticorum.*

Observer.	Date.	Ill. end of axis.	A.	B.	C.	D.	E.	F.	G.	Seconds of Dec. + lev. corr.
				m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	″
B^2	Jan. 5	S.		25 35.5	41 9.0	52 22.0	61 34.5	69 34.2	76 43.0	35.78
Val. of $L_s - D$				2′ 40″.08	6′ 54″.24	11′ 11″.50	15′ 29″.31	19′ 47″.44		
			m. s.	m. s.	m. s.	m. s.	m. s.	m. s.		″
B^2	Dec. 28	N.	76 33.5			52 11.5	40 55.9			40.30
B^2	30	N.	30.2	69 17.0	61 18.5	8.0	48.7	24 57.0		41.71
Mean		N.	76 31.85	69 17.00	61 18.50	52 9.75	40 52.30	24 57.00		41.00
Val. of $L_n - D$				19′ 37″.69	15′ 21″.25	11′ 6″.26	6′ 48″.66	2′ 32″.14		
$L_n - D$ reduced to $L_s - D$				19 43.62	15 27.18	11 11.48	6 53.88	2 38.07		
$\frac{1}{2}(L_n \backsim L_s)$				8 31.77	4 16.47	0.01	4 17.72	8 34.68		
$\frac{1}{2}(L_n + L_s) - L$				1.39	0.35	0.00	0.35	1.40		
$L_n \backsim L_s$				8 33.16	4 16.82	0.01	4 17.37	8 33.28		
$L_s \backsim L$				8 30.38	4 16.12	0.01	4 18.07	8 36.08		

TABLE VII.

Computation of the Constants for the Reduction of the Hour Angles of α Lyræ to the Axis of Collimation.

Observer.	Date.	Ill. end of axis.	Interval of Passage from E. to W. Transit over Wire A.	B.	C.	D.	E.	F.	G.	Seconds of Dec. + lev. corr.
			h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	"
B^1	Dec. 16	S.	3 43 37.7	45 55.8	48 11.6	50 26.7	52 41.1	54 55.2		42.04
G	23	S.	39.2	56.8	12.5	27.0	41.7	54 3	57 5.6	40.16
Mean		S.	3 43 38.95	45 56.30	48 12.05	50 26.85	52 41.40	54 54.75	5.60	41.10
B^1	Dec. 19	N.	3 57 5.0	54 53.0	52 41.2	50 27.4	48 12.0	45 56.2	43 38.5	40.91
B^1	29	N.	6.0	54.0	42.1		14.9			36.85
Mean		N.	3 57 5.50	54 53.50	52 41.65	50 27.40	48 13.45	45 56.20	43 38.50	38.88
N. Interval reduced to lev. and decl. of S. int.			3 57 4.25	54 52.27	52 40.43	50 27.11	48 12.27	45 55.92	43 38.67	
½ diff. of N. and S. intervals			6 42.65	4 27.98	2 14.19	0 0.13	2 14.56	4 29.42	6 43.46	
Corr. of half sum of N. and S. intervals			5.36	2.37	0.60	0.00	0.60	2.37	5.36	
Corr. of intervals		S.	6 48 01	4 30.35	2 14.79	0 13	2 13.96	4 27.01	6 38 10	
Corr. of intervals		N.	6 37.29	4 25.61	2 13.59	0.13	2 13.16	4 31.79	6 48.82	

TABLE VIII.

Latitude of the Cambridge Observatory, neglecting the Deviation of the Plane of the Telescope from the Prime Vertical.

1. *From α Lyræ.*

Observer.	Date.	Ill. end of axis.	Transit.	Latitude from Wire A.	B.	C.	D.	E.	F.	G.	Mean.	No. of Obs.
B^2	Dec. 15	N.	W.	42° 22′ "	"	"	50.41"	"	"	"	50.41"	½
B^1	16	S.	E. & W.	48.23	47.11	47.59	48.47	49.09	51.11	48.41 W.	48.59	6½
B^1	19	N.	E. & W.	48.80	48.16	48 60	47.92	47.70	49.36	48.02	48.37	7
B^2	20	S.	E.	49.27	49.15	50.82	50.59	51.74	50.43	51.46	50.49	3
G	23	S.	E. & W.	47.45	47.28	47.61	47.29	48.51	47.53	48 03	47.67	7
G	24	N.	E.	50.66	48.42	48.05	49.89	49.76	49.62	49.27	49.38	3
B^1	29	N.	E. & W.	47.45	46.81	47.05	45.95 E.	51.25	46.41 E.	47.03 E.	47.67	5½
B^1	Jan. 1	S.	W.	47.93	50.33	48.07	47.83	46.57	50.07		48.47	3
Mean				42 22 48.33	47.87	48.06	48.36	49.19	49.23	48.47	48.47	35½

2. *From β Persei.*

Observer.	Date.	Ill. end of axis.	Transit.	A.	B.	C.	D.	E.	F.	G.	Mean.	No. of Obs.
B^2	Dec. 14	N.	E. & W.	42 22 48.01	48.40	48.64	49.00	49.64	50.21	49.49	49.12	7
B^2	16	S.	E. & W.	48.26	48.16	49.12	48.10	49.85	48.30	48.01	48 54	7
B^2	17	S.	E.	47.91	48.17	45.92	48.02	49.49	45.37	46.51	47.34	2
B^1	18	N.	E.	47.78	49.05	48.87	51.65		49.61	49.78	49.46	2
B^2	20	N.	E. & W.	47.63	47.64	48.05	47.48	49.05	49.59	49.04	48.35	7
G	24	S.	E.	49.00	49.47	49.40	49.43	50.01	47.79	49.03	49.16	2
G	25	N.	E. & W.	48.41	47.63	48.81	47.26	48.65	48.54	48.45	48.19	7
G	26	S.	E. & W.	48.07	47.20	47.97	47.79	48.61 E.	46.01 E.	47.53 E.	47.66	5½
Mean				42 22 48.10	47.99	48.44	48.22	49.29	48.63	48.62	48.47	39½

TABLE VIII. — Continued.

3. *From γ^1 Andromedæ.*

Observer.	Date.	Ill. end of axis.	Transit.	Latitude from Wire A	B.	C.	D.	E.	F.	G.	Mean.	No. of Obs.
B^1	Dec. 12	N.	E. & W.	42° 22′ 48″.09 W.	48″.69 W.	48″.37	48″.47	48″.20	48″.06	46″.98	48″.08	6
B^1	14	N.	E. & W.	48.92 W.	48 20 W.	49.11 W.	49.79	49.56	48.61	49.23	49.15	5½
B^1	16	S.	E. & W.	47.98	48.79	48.76	49.69	48.45	49.28	49.36	48.87	7
B_1^2	17	S.	E. & W.	48 82	49 35	49.19	49.50	49 80	49.34	48.33	49.16	7
B^1	18	N.	E. & W.	48.90	48.93	48.26	49.34	50.18	50.29	48.79	49.24	7
B^2	20	N.	E. & W.	48.49	49.75	49.31	49.59	49.08	49.44	48.95	49.23	7
G	24	S.	E.	48.98	47.98	50.20	49.65	49.04	48.84	49.17	49.12	3
G	25	N.	E. & W.	49.09	48.95	49.32	49.54	48.73	48.60	47.79 E.	48.94	6½
G	26	S.	E. & W.	48.40	48.97	47.57	48.84	47.77	47.86	46.86	48.04	7
B^1	Jan. 2	S.	E. & W.	49.91	49 80	49.40	49.75	50.59	49.91	49.39	49.82	7
	Mean			42 22 48.78	49.07	48.87	49.40	49.15	49 04	48.49	48.96	63

4. *From μ Ursæ Majoris.*

Observer.	Date.	Ill. end of axis.	Transit.	A	B.	C.	D.	E.	F.	G.	Mean.	No. of Obs.
B^1	Dec. 12	N.	E.	42 22			48.84				48.84	½
B^2	17	S.	E. & W.				49.25	48.45			48.85	2
B^2	28	N.	E. & W.			47.49 E.	48.86	48.48			48.43	2½
B_1^2	29	S.	E. & W.			50.02	49.74	50.07			49.94	3
B^2	30	N.	E & W.			49.14	48.25	48.05			48.48	3
B^2	Jan. 1	S.	E. & W.			47.47	48.62	48.25			48.11	3
B^2	5	S.	E. & W.			47.25 E.	47.30	47.26			47.27	2½
	Mean			42 22		48.50	48.68	48.44			48.54	16½

5. *From 8 Canum Venaticorum.*

Observer.	Date.	Ill. end of axis.	Transit.	A	B.	C.	D.	E.	F.	G.	Mean.	No. of Obs.
B^2	Dec. 28	N.	E. & W.	42 22	47.29 W.	47.79 E.	47.31	47.53	46.47		47 32	3½
B^2	30	N.	E. & W.		46.24	46.14	47.23	46 54	47.13		46.66	5
B^2	Jan. 2	S.	E. & W.		46.24	46.14	47.28	47 02	47.14		46.76	5
	Mean			42 22	46.45	46.41	47.27	47.03	47.00		46 87	13½

TABLE IX.

Observations for the Azimuth of the Telescope.

(All the transits were east of the meridian.)

Observer.	Date.	Ill. end of axis.	Name of Star.	Time of Transit over Wire A.	B.	C.	D.	E.	F.	G.	Mean Time of Transit.	Computed Time of Transit over Prime Vertical by Chronom.	Error from Azimuth.
				h. m. s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
B^1	Dec. 12	N.	α Can. Min.	1 53 3.6	29.4	54.5	80.5	105.6	131.5	156.8	80.2	76.5	3.7
B^1	12	N.	α^2 Gemino	3 57 45.5	81.0	116.1	151.7	187.6	223.5	259.2	152.0	148.3	3.7
B^1	12	N.	β Gemino	4 15 46.7	87.7	128.9	169.8	211.7	253.4	294.5	170.3	167.0	3.3
B^2	14	N.	α Can. Min.	1 53 2.0	27.5	53.0	78.5	104.0	129.5	155.5	78.5	75.4	3.1
B^2	17	S.	α Can. Min.	1 53 154.3	129.0	103.5	78.0	52.7	26.6	1.5	78.0	73.1	4.9
B^2	20	N.	α Can. Min.	1 52 58.0	83.5	109.0	134.7	160.5	186.0	211.5	134.6	130.9	3.7
G	24	S.	α Can. Min.	1 52 209.6	184.0	158.5	133.0	107.5	81.2	36.0	132.9	129.1	3.8
G	25	N.	α Can. Min.	1 52			133.0	158.6	184.5	210.0	133.2	128.4	3.8
G	25	N.	β Gemino	3 57 37.6	73.4	108.5	144.3	180.2	156.0	251.8	144.3	140.2	4.1
G	26	S.	α Can. Min.	1 52 210.0	184.0	158.5	133.0				133.1	130 0	3.1

Azimuth Error from Observations of α Can. Min. = 37″.6 Corr. of Lat. = 0″.004
" " α^2 Gemino = 37.4 " " = 0.004
" " β Gemino = 37.4 " " = 0.004

so that the correction of latitude is insensible.

TABLE X.

Latitude, of the Cambridge Observatory, from each Observer and Star.

Name of Star.	W. C. Bond.		Major Graham.		George P. Bond.		Mean.	
		No. of Observations.		No. of Observations.		No. of Observations.		No. of Observations.
α Lyræ	42° 22′ 48″.37	22	48″.28	10	50″.58	3½	48″.57	35½
β Persei	49.46	2	48.12	14½	48.55	23	48.47	39½
γ^1 Andromedæ	49.10	36	48.47	16½	49.20	10½	48.95	63
8 Canum Venaticorum					47.05	13½	47.05	13½
μ Ursæ Majoris	49.53	2			48.25	14½	48.40	16½
Mean Latitude	42 22 48.83	62	48.29	41	48 86	65	48.60	168